A LETTER

TO

DR. LYON PLAYFAIR, C.B. F.R.S.

BEING A MEDICAL COMMENTARY

ON THE RESULTS OF THE RECENT

ANALYSIS OF THE BUXTON TEPID WATER.

TO WHICH ARE PREFIXED

A STATEMENT OF THE IMPROVEMENTS NOW IN PROGRESS AT BUXTON.

AND

DR. PLAYFAIR'S ANALYTICAL REPORT.

BY

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LONDON:
BRADBURY AND EVANS, BOUVERIE STREET.
1852.

LONDON:
BRADBURY AND EVANS, PRINTER, WHITEFRIARS.

PREFACE.

A FEW words of introduction appear to be necessary. The town and baths of Buxton had ceased to be capable of affording an adequate amount of accommodation to the yearly increasing number of invalided visitors, and it was at length determined by the noble owner of the baths and adjacent property, that extensive alterations and additions should be made, in order to meet the wants and requirements of the public. It was in connection with this movement, that the analytical report of Dr. Playfair was obtained, on the part of the Duke of Devonshire.

The extension and alteration of the baths have been of the most efficient character. For immediate purposes, in addition to the range of hot baths erected many years ago, two new hot baths have been erected; and the whole of these will soon be replaced by an entirely new and extensive range of hot baths and warm swimming baths, now in course of erection, where baths may be obtained of the Buxton tepid water, heated to any higher degree of temperature than the natural heat of the water, which is 82 degrees; and where douches of all kinds, and of any required temperature, adapted to any purpose which douches can subserve, will be provided. A new range of baths, where the water is used at the

natural temperature, has already replaced the older, and more limited, and less efficient structure and amount of accommodation. Covered with a roof of glass, an elegant, spacious, and commodious building contains no fewer than five large swimming baths, of the water at the natural temperature; and ranges of private baths with douches, and of douche closets, for the use of the douche without the use of the bath, will, it is hoped, supply all the requirements of the various invalids resorting to Buxton.

In connection with these improvements, and the needful excavations for the foundations and levels of the baths, a considerable additional supply of the natural water has been obtained: a supply which serves to fill completely a pipe of nine inches in bore, from a source which did not quite fill a pipe of six inches in bore previously; and the flow is ascertained to be increased from 83¼ gallons per minute to the considerable quantity of 120 gallons per minute, and at the genial temperature of 82 degrees.

In addition to these accommodations for the wants of those who seek relief at Buxton for their several ailments, it should be stated, that the already extensive public walks have been much added to and embellished; and that upwards of one hundred acres of ground, close to the town, have been thoroughly drained for building purposes, laid out and planted after designs by Sir Joseph Paxton, and roads and walks being carried throughout, and sites marked for the erection of villas (many of which have been already secured); all which must add to the attractions, resources, and accommodations of the place.

Buxton, *August*, 1852.

DR. PLAYFAIR'S REPORT

ON THE

WATER OF THE THERMAL SPRINGS OF BUXTON.

Museum of Practical Geology, and Government
School of Mines,
London, July 24th, 1852.

TO SYDNEY SMITHERS, ESQ.

Sir,

In consequence of a request made by you, on behalf of his Grace the Duke of Devonshire, I visited Buxton on the 8th and 9th of April, for the purpose of collecting the water of the thermal spring for analysis.

The water was collected partly in glass-stoppered bottles, and partly in earthenware jars. The gas, as it issued from the crevices of the rock and bubbled through the water, was caught by an inverted funnel, and collected in glass bottles filled with the thermal water itself. These bottles were then sealed on the spot; and the evidence derived from the gas contained in them, shows that the precautions used for preventing the access of air were quite successful.

It is not necessary for me to describe the physical conditions under which the thermal springs appear at Buxton. It may be sufficient to state, that they issue from fissures in the limestone, and are accompanied by frequent, but intermittent bursts of gas, which escapes partly as large bubbles, and partly in innumerable small

bubbles, giving to water freshly collected in glass vessels, all the appearance of soda water.

The water is clear, sparkling, inodorous, and when cool is almost tasteless. Its temperature is 82° Fahrenheit, and its specific gravity 1·0003.

Two points had specially to be attended to in the analysis of the waters,—firstly, to ascertain the nature and quantities of the ingredients in solution, and, secondly, the character and composition of the gas accompanying them.

In order to be sure that every ingredient came under my observation, I caused 100 gallons of the water to be evaporated down to about half a gallon, and examined the deposit and residual solution for bodies which might be present in such small quantity as to escape detection in the unconcentrated water. The precaution was found to have been necessary, for, in addition to the ordinary constituents of the waters, two more rarely occurring bodies —viz. fluorine and phosphoric acid—were found to be present, although only in minute quantity. The amount of fluorine was, however, sufficient to etch glass when applied with proper precautions. Neither iodine nor bromine could be detected.

The following analysis gives the amount and nature of the solid ingredients in one imperial gallon of the water at 60° :—

	Grains.
Silica	0·666
Oxide of iron and alumina	0·240
Carbonate of lime	7·773
Sulphate of lime	2·323
Carbonate of magnesia	4·543
Chloride of magnesium	0·114
Chloride of sodium	2·420
Chloride of potassium	2·500
Fluorine (as fluoride of calcium)	trace
Phosphoric acid (as phosphate of lime)	trace
	20·579

On examining the water, there were found present carbonic acid and nitrogen, in addition to the solid ingredients. It was important to estimate the amount of the former in an exact manner. Some of the water was received from the spring into a glass-stoppered bottle, and the stopper was immediately inserted and secured. One gallon of the water was found to contain altogether 13·164 grains of carbonic acid; but of this quantity, 5·762 grains were due to the carbonates of lime and magnesia, and therefore only 7·402 grains could in any sense be considered as free. Again, the carbonates of lime and magnesia are present as bicarbonates, or as carbonates dissolved in carbonic acid, and 5·762 grains of carbonic acid would require to be added for this purpose. Hence, of the 7·402 grains, or 15·66 cubic inches of gaseous carbonic acid in the water, only 1·640 grain, or 3·47 cubic inches, can be considered as wholly free and uncombined.

The nitrogen in the water could only be present in solution, and not in combination; and as there is no very accurate method for ascertaining the precise quantity of this gas in the water at any given temperature, it was considered chiefly important to ascertain accurately the composition of the escaping gas, as this would indicate that of the gas held in solution. The following are the analyses of two portions of the gas collected as formerly described, the analyses being given *according to volume.*

	I.	II.	mean.
Carbonic acid	1·169	1·164	1·167
Nitrogen	98·831	98·836	98·833
Oxygen	trace	trace	trace
	100·000	100·000	100·000

The gas, therefore, consists entirely of carbonic acid and nitrogen; for the oxygen, which did not amount to

one-tenth per cent., may be viewed as quite accidental, arising probably from the corks used to close the bottles.

Judging from the analysis and proportion of the gases, it is assumed that, *at the moment of issue*, the water is charged with 206 cubic inches of nitrogen, and 15·66 cubic inches of carbonic acid. This assumption is founded upon the proportional relation of the two gases. The proportion of carbonic acid in the water being determined, and the proportion of carbonic acid to that of nitrogen contained in the water being 1·2 to 98·8, the amount of nitrogen contained in the water at the moment of issue may fairly be assumed to be 206 cubic inches per gallon.

Before remarking further on the above analysis, it may be useful to refer to that by Scudamore. The analysis given by him was upon the wine gallon, which is one-fourth less than the imperial gallon. Correcting for this difference, Scudamore found 20 grains of solid matter in a gallon—a result not materially different from that detailed above. The solid ingredients do indeed differ to some extent in the two analyses; but it must be recollected that analytical chemistry is now in a much more advanced state; and, instead of being surprised at the differences, we are rather inclined to admire the precision with which the points had been made out.

From a consideration of the previous analysis, I am inclined to ascribe the medicinal effects of the water almost entirely to its gaseous constituents. The water, deprived of its gases, has the composition of an ordinary spring water, with the exception of the fluorine and phosphoric acid, both of which are present in mere traces; and it is therefore difficult to conceive that they can have any medicinal effect when the water is used for baths. The gases are, however, nearly of the same composition as those of the thermal spring at Bath, and there is no

reason to doubt that dissolved carbonic acid and nitrogen may exert important physiological effects. At all events, the singular chemical character of the Buxton tepid water must be ascribed to its gaseous and not to its solid ingredients.

Sir,

I have the honour to be

Your obedient and faithful servant,

LYON PLAYFAIR, F.R.S.

TO DR. LYON PLAYFAIR.

Dear Sir,

I have read your analytical report on the water of the thermal springs of Buxton with much attention. Your analysis justifies a much enlarged expectation as to the value of this great mineral water, as founded upon what is known of its chemical constitution; and it removes the water from the list of mineral waters which seem to act on the system by unknown means only, or in virtue only of undetected constituents. Your unexpected discovery that this water may be fairly assumed to contain 206 cubic inches of nitrogen per gallon, at the moment of its issue, necessarily leads to important inferences respecting its value as a medicinal agent, independently of the ancient fame of the Buxton tepid water, and independently of its ascertained effect in the cure of disease. As the chemistry of healthy structure and function, and of diseased states, becomes of greater practical and paramount value, it is probable that a re-agent poured forth from the bowels of the earth with so much and such unceasing rapidity as the free nitrogen contained in this water, may come to be applied with precision and confidence to the relief of many diseased or disordered conditions. It seems to be probable that

the great effect of this water upon some diseases, which has been so long known and so largely appreciated, may be thus in some degree explained; even if the effect of introducing so much free nitrogen into the system may not aid, in its turn, in explaining the nature of the diseases on which this water acts so energetically. So long as 5·57 cubic inches of nitrogen, per imperial gallon, were supposed to be the whole amount of this important element contained in the water, it appeared to be a reasonable inference that but little if any of the medicinal effect could be ascribed to it. It must be granted that the results of your analysis cause the question to be presented under a very different aspect.

In regard to the solid constituents of the Buxton tepid water, it is only indirectly that the result of your analysis can be considered to be important. It was, indeed, needful, and only the just due of a mineral water to which the long continued and large resort of those suffering from gout, rheumatism, &c., attached much importance, that the more advanced state of chemistry should be brought to bear upon it from time to time, in order to determine how far what might be ascertained of its composition would bear out and explain its remedial efficacy. And your analysis serves to show that analytical chemistry has made great advances since the date of the preceding analysis of the water, although it has failed to discover the presence of any great re-agent among its solid constituents in such important quantity as might justify an inference as to its medicinal action. But it must surely be regarded as a step in advance of some significance and value, that the presence of silica, oxyde of iron, alumina, fluorine, and phosphoric acid should have been now detected for the first time, even although

the proportion of these ingredients is not so great as to assist in explaining the medicinal action of the water. And since the presence of these ingredients in the water had not been detected even during the analytical investigation that was conducted with so much care by the late Sir Charles Scudamore and Mr. Garden, with all the appliances which chemistry had to offer at that time, and which obtains your own well-deserved praise, it may surely be hoped that, as chemistry advances nearer and nearer to perfection in its processes and teachings, it will lend further and further aid in explaining the effect of this water on the human system. In the mean time it must be conceded, if the effect of the water is to be referred to what is now known as to its composition, such effect cannot be ascribed to its solid constituents.

In respect to the gases which this water holds in solution, the result of your analysis is much more satisfactory and important. Instead of 1·8 cubic inch of carbonic acid in the imperial gallon of the water, which was the result of the preceding analysis, your statement shows that there are 3·47 cubic inches per gallon, after deducting for every form in which the remaining 12·19 cubic inches are held in combination. But free carbonic acid, when contained in large proportion in mineral water, is not found to have much medicinal effect on the animal economy. Carbonic acid is chiefly valuable in such water as a solvent for more powerful re-agents, or as a medium by which its more rapid absorption into the system may be promoted, either when used as baths or taken internally. It is in this secondary way only, that it is needful to regard the larger proportion of carbonic acid which your analysis has obtained from the Buxton tepid water—a proportion which, after all, is small

when compared with the amount that is contained in many mineral waters.

That no less than 206 cubic inches of free nitrogen may be now fairly assumed to be present in the imperial gallon of the Buxton tepid water at the moment of its issue, is a much more important and interesting result of your analysis—a result which, when multiplied by the 120 gallons discharged from these springs per minute, shows that no less than 24,720 cubic inches of nitrogen are discharged with this water per minute. Much of this great result may be due to the improved methods now possessed for ascertaining the character and proportions of the gaseous constituents, and the result may be partly owing to the care which you took to secure the whole of the gaseous contents in the water to be analysed.

If the free application of uncombined nitrogen to the surface of the body, or to the lining membrane of the stomach, is capable of influencing the system in any important degree, the medicinal effect of the tepid water of Buxton must be admitted to be so far explained. Whatever might be the effect of the gaseous constituents of the water upon the system, it might be inferred that such effect would be rapidly developed; and any difference of effect between the use of this water and that of common spring water at the same temperature, which may be experienced at the time of bathing in it or immediately afterwards, or at the time of drinking it or immediately afterwards, may perhaps be referable to the large amount of free nitrogen which it has now been shown to contain. With this better information as to the amount of the constituent gases, it need no longer be matter of surprise that the internal use of the water is so often attended with some degree of dizziness immediately after drinking it, or

even that, in much rarer cases, its immediate effect is to stimulate to the extent of intoxication ; and it need be no longer matter of surprise that the use of the bath of this water is usually followed by so remarkably perfect a degree of reaction; or that, whether the water is externally or internally used, the appetite and digestion should be so generally and to so great a degree promoted, and the vascular and nervous systems so appreciably stimulated. These effects, in whatever degree they may be presented, may probably be referred to the influence of so large an amount of nitrogen, thus offered to the system in a free and readily available condition.

But the Buxton tepid water has a secondary and more important and more lasting effect on the system—an effect which is only manifested twelve, eighteen, or twenty-four hours after using the bath, and, in regard to the internal use of the water, when the bath is not used at all, only manifested when its use has been continued for several successive days—an effect well described as the water-fever, from being evidenced by a greater or less amount of general febrile action. In some cases, a greater or less degree of this feverish condition attends the whole subsequent continuance of the use of the water ; and, in most instances, this feverish state is followed by a degree of languor, and eventually of debility, that usually corresponds in some measure with the amount of febrile excitement, being, however, subject likewise to the modifying influences of age, sex, temperament, ailment, &c. This great secondary effect of the Buxton tepid water, with which its action and value as a curative agent is intimately connected, may have to be ascribed to the presence of some hitherto undetected constituent or constituents, which the chemistry of a future time may be able to discover. It will probably be thought by some

persons, nevertheless, that a large admission of free nitrogen to the blood, whether through the skin or through the mucous membrane, may immediately stimulate, and, if the introduction be continued, may more permanently excite, and may eventually exercise an important degree of alterative action on the human economy. Such a degree of alterative action is the eventual effect of a course of the Buxton tepid water, whether it is used externally or internally, but more especially and certainly when used in the form of a bath. The alterative effect of the water is often of long continuance, perceptibly influencing the system after the use of the water has been discontinued for a considerable length of time; and, when the water has been used unduly, or when it has been used under improper circumstances, often inducing much debility and its attendant evils.

It is a very gratifying result of your analysis that it can be no longer charged against this water, that its composition would justify an *à priori* inference against its medicinal value. An important amount of effect might be predicated for a mineral water so highly charged with nitrogen gas as the Buxton tepid water is now known to be. According to the respective analyses, this water is assumed to contain more than half the proportion of free nitrogen that the Seltzer water contains of carbonic acid—a statement which clearly shows how very large a proportion of nitrogen is contained in the Buxton warm springs. And although it might not be exactly fair to institute an unqualified comparison between what has been so recently ascertained as to the amount of nitrogen contained in this water, and that contained in other mineral waters, according to analyses of older date, and therefore of less authentic character, it is impossible to avoid an

inference that the great immediate effect which so often attends the use of this water, the interruptions of its use as a bath (bathing only three or four, or at most five times a-week), which experience has proved to be needful to its being used with safety—precautions which do not seem to be necessary in the use of baths of other mineral waters of high repute—may indicate that such waters are not thus charged with this gas, even if they contain any amount whatever of free nitrogen in their composition. And when it is remembered that the late distinguished chemist, Professor Thomson, of Glasgow, denied altogether his belief in the existence of free nitrogen in the Buxton tepid water, maintaining that the proportion of oxygen required to be added to the nitrogen to compose atmospheric air, would be found if the gases were properly examined, and that, therefore, the greater proportion of the gas in this water would be found to be merely imbibed from the atmosphere, and this notwithstanding the analytical statement of Sir Charles Scudamore and Mr. Garden; —and when it is remembered that Dr. Thomson was one of the greatest analytical chemists of his day, and that he was peculiarly versed in the analyses of the various mineral waters,—the opinion that the Buxton tepid water may enjoy a great, if not a singular, degree of pre-eminence in this respect, appears to become considerably strengthened. It should be added that the original discovery of free nitrogen in this water is due to Dr. Pearson. In Sir Charles Scudamore's words, "he (Dr. Pearson) had the merit of discovering the separate existence of azote in this water—a principle which had never been detected by any preceding chemist in any water." The date of Dr. Pearson's analysis is 1784. The date of the analysis by Sir Charles Scudamore and Mr. Garden is 1820. It will be observed that there is an interval of

thirty-six years between the first and the second of these analyses, and of thirty-two years between the second and your own analysis.

According to all these analyses, of such distant respective dates, the Buxton tepid water was found to contain a certain proportion of free nitrogen. According to the different analyses of the great warm mineral spring at Bath, the most various results are set forth. A recent analysis, by M. Walcker, the celebrated German chemist, assigns to the Bath thermal water only 0·40 cubic inches per imperial gallon of carbonic acid, and only 14 cubic inches of atmospheric air, there being no mention whatever of free nitrogen. An analysis by Professor Daubeny assumes that there are 96 per cent. of nitrogen in the thermal water of Bath. The satisfactory character of this statement is, however, considerably detracted from, by the circumstance that, in addition to carbonic acid and nitrogen, oxygen was found in the Bath mineral water. It should, moreover, be borne in mind, that in the instance of the Bath water, and in that of most of the great mineral waters, even should future analyses assume for them as large a proportion of free nitrogen as is assumed by your analysis for the Buxton tepid water, the water issues from the earth at so high a degree of temperature as to be unfit for immediate use, either externally or internally; such water has to be cooled considerably, either by exposure to the air or by the addition of colder water, before it can be used as a bath or taken into the stomach; and thus the gaseous constituents must be dissipated in an important degree; whereas the temperature of the St. Ann's springs, at Buxton, enables this water to be used in its natural state, without exposure or dilution, securing that its effects, so far as these may be dependent upon the presence of

nitrogen, are not impaired. The inference is, that so far as the nitrogen may have to do with the efficacy of this water, even the addition of heated water of any prescribed quantity, in order to afford a bath of such greater heat as may be suitable for exceptional cases, may not render the water of weaker character, in regard to the gaseous constituents, than the exposure or dilution which the high temperature of many mineral waters always renders necessary.

I would venture to reiterate, as a possibly needful corollary to the above statements and inferences, the opinion, that all the medicinal effects of the Buxton tepid water, and especially its great alterative action, can scarcely be ascribed even to the large proportion of nitrogen which it must now be held to contain (significant and valuable as this must be admitted to be), but may still be referable to the presence of some hitherto undetected constituent. However this may be, the great and singularly lasting effects of these baths, and of the internal use of this water, are unquestioned and indisputable. Their use is almost specific for the relief or alleviation of most cases of rheumatism, and of many cases of gout, for which the use of other means and appliances has been sought and tried in vain. In proof of this, the fact may be adduced, that large numbers of poor handicraftsmen, who have proved the effect of this water on their suffering and imperfectly usable limbs, are known to undergo great privations, in order to secure its use at stated intervals, from finding that no other means within their reach enables them to maintain such a state of their joints as is needful to enable them to follow their employment. The yearly reports of the Buxton Bath Charity certify, that of 15,497 patients, for the most part sufferers from rheumatism, admitted to

the benefit of the institution, from the year 1838 to 1851, only 613 had to be sent home as being "no better," the large proportion of 11,740 having been discharged as "cured or much relieved."

I am, dear Sir,

Most faithfully yours,

WILLIAM HENRY ROBERTSON.

BUXTON, *August 9th*, 1852.

BRADBURY AND EVANS, PRINTERS, WHITEFRIARS.